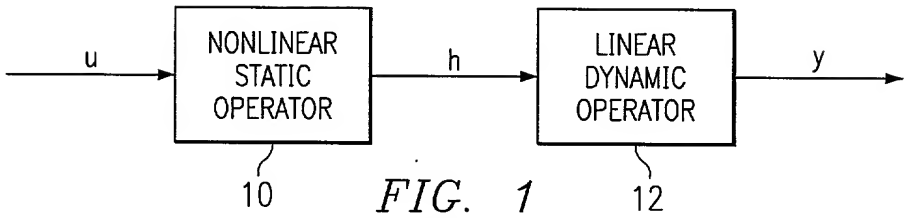


FIG. 1
(PRIOR ART)

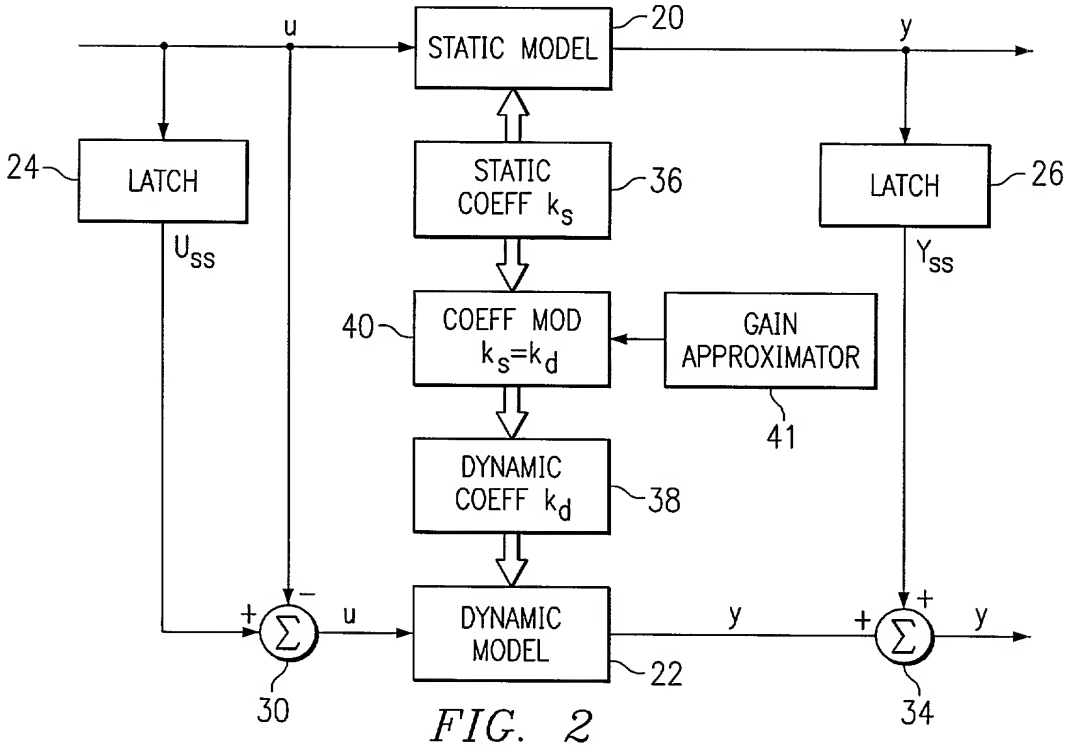


FIG. 2

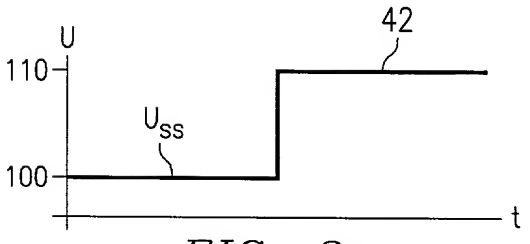


FIG. 3a

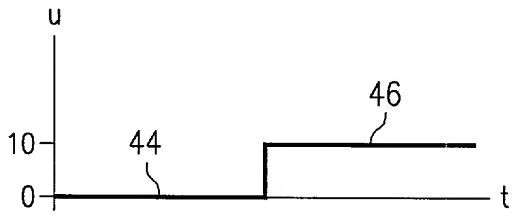


FIG. 3b

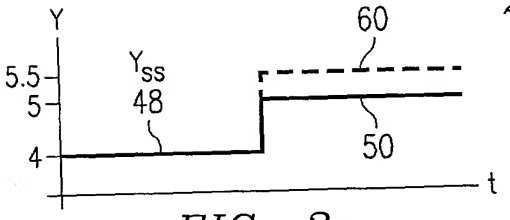


FIG. 3c

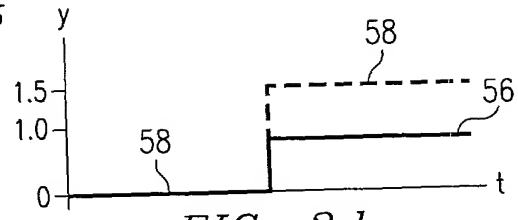


FIG. 3d

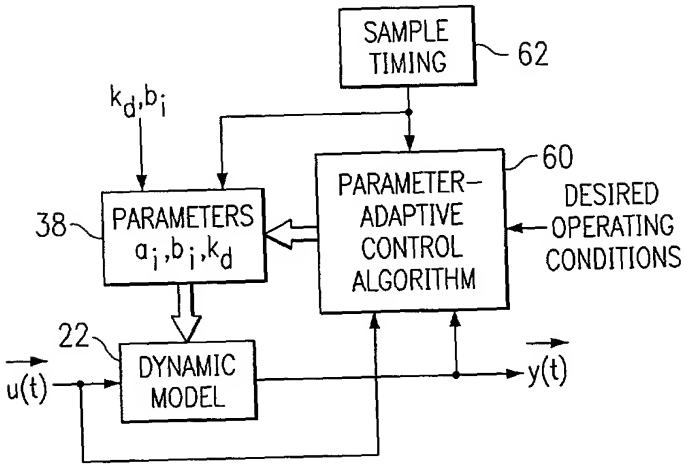


FIG. 4

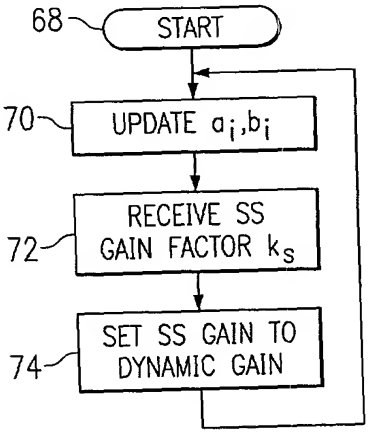


FIG. 5

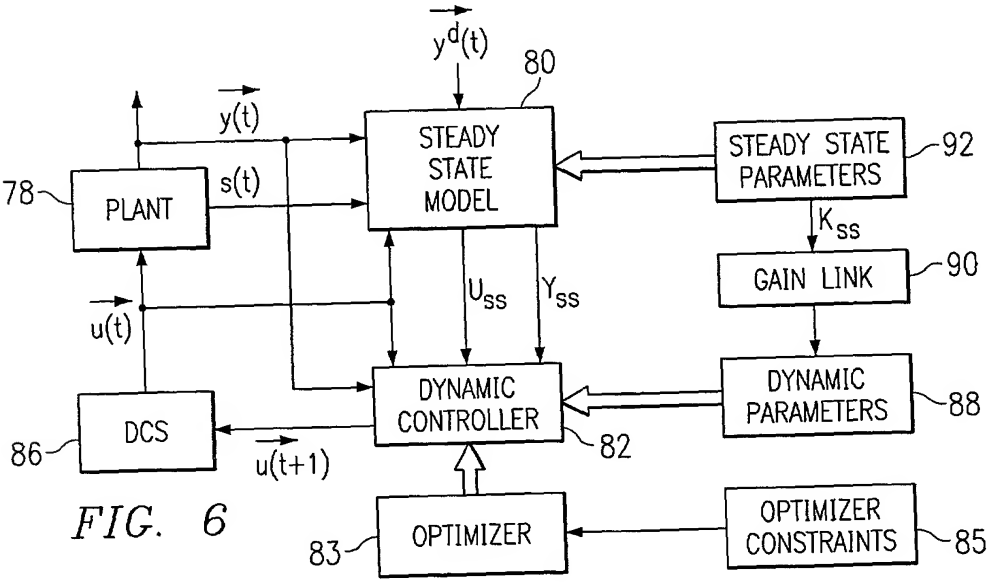


FIG. 6

FIG. 7

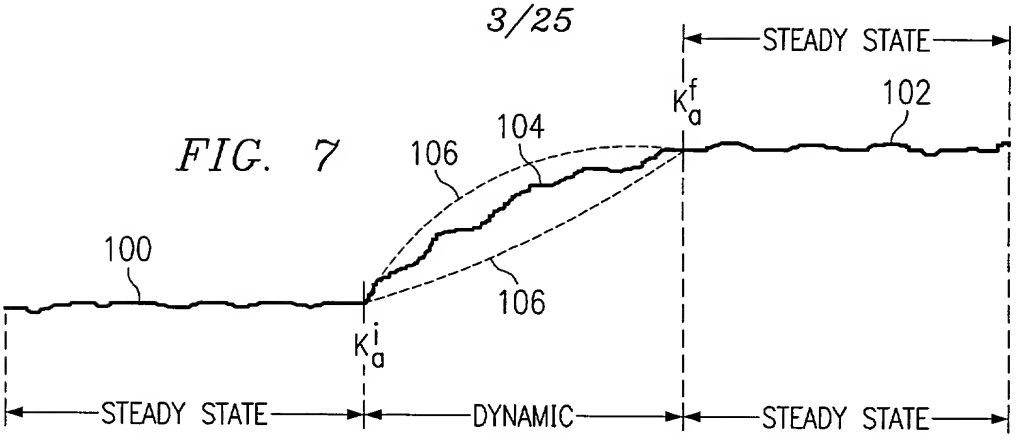


FIG. 8

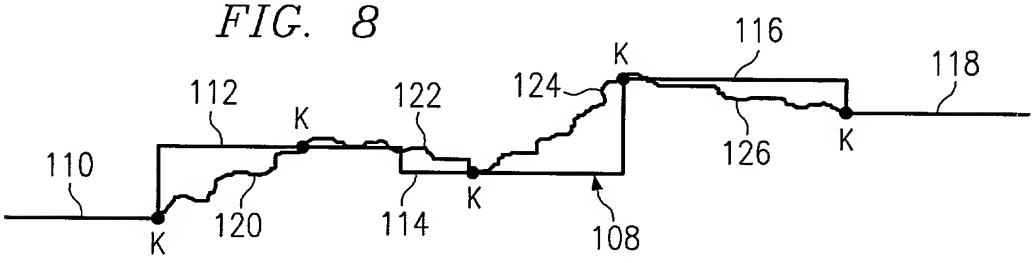
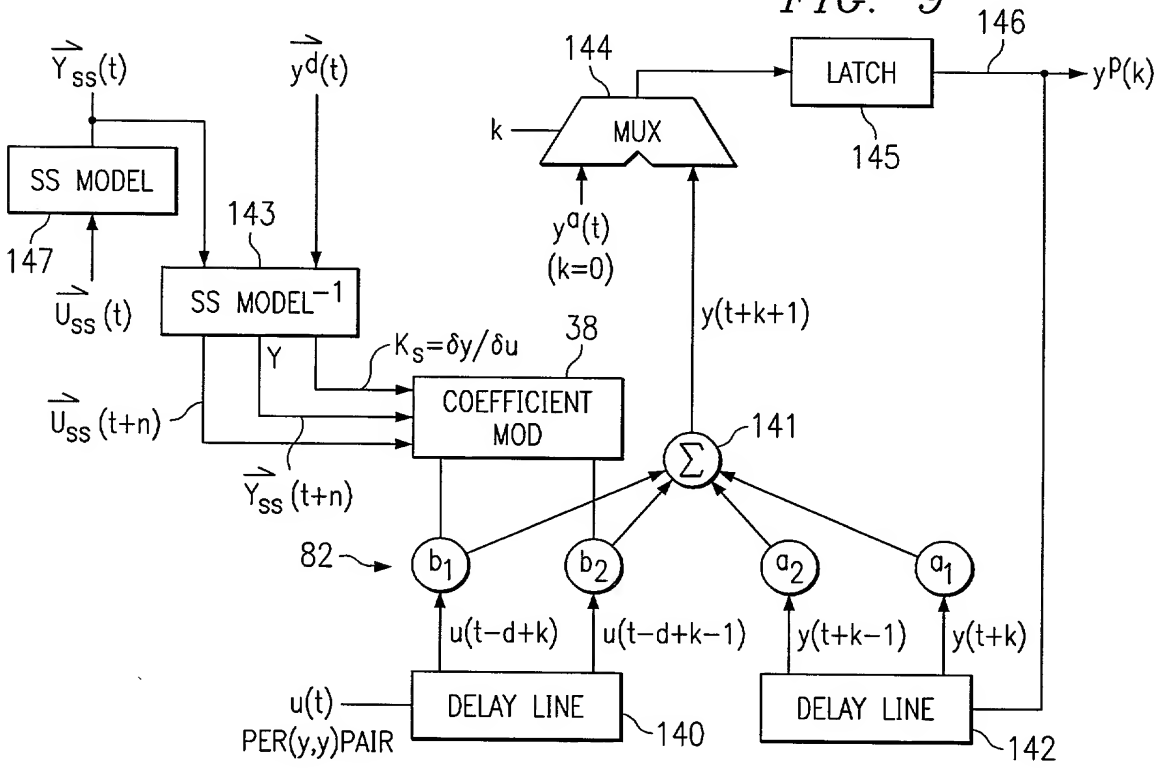


FIG. 9



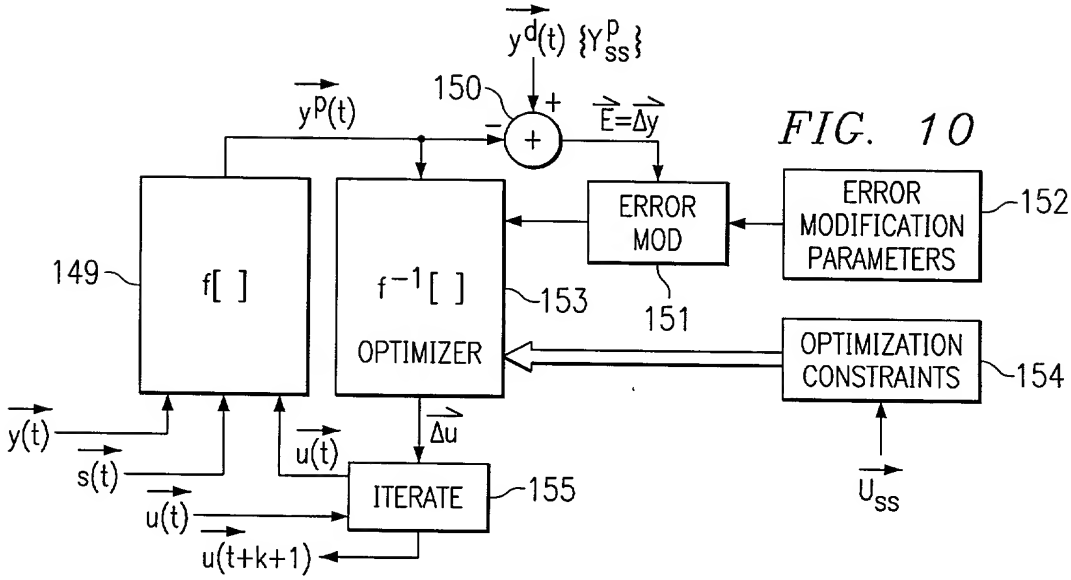


FIG. 10

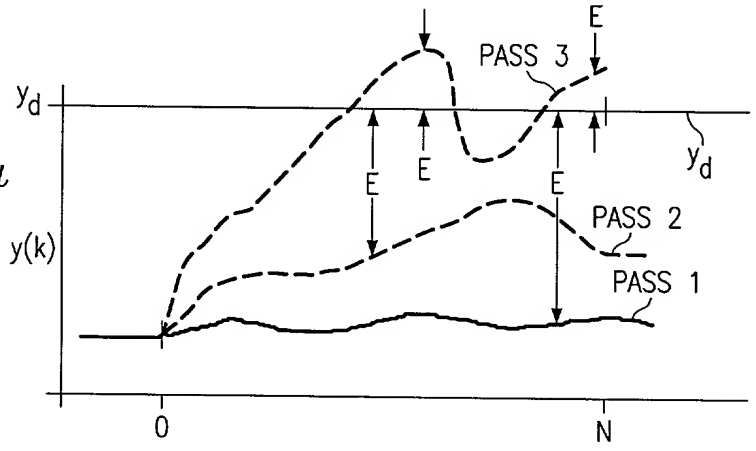


FIG. 11a

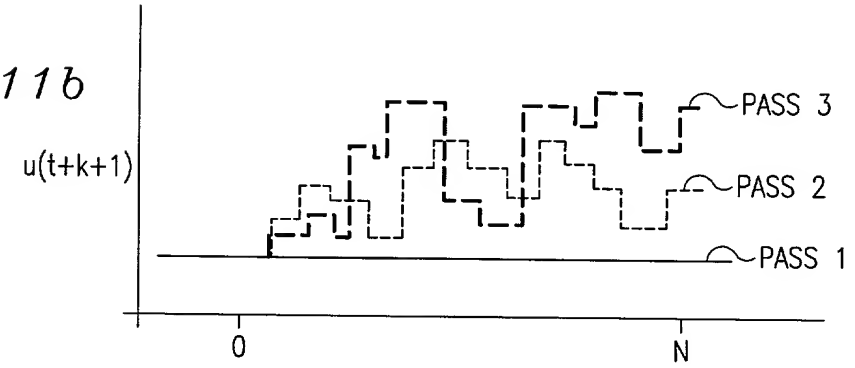


FIG. 11b

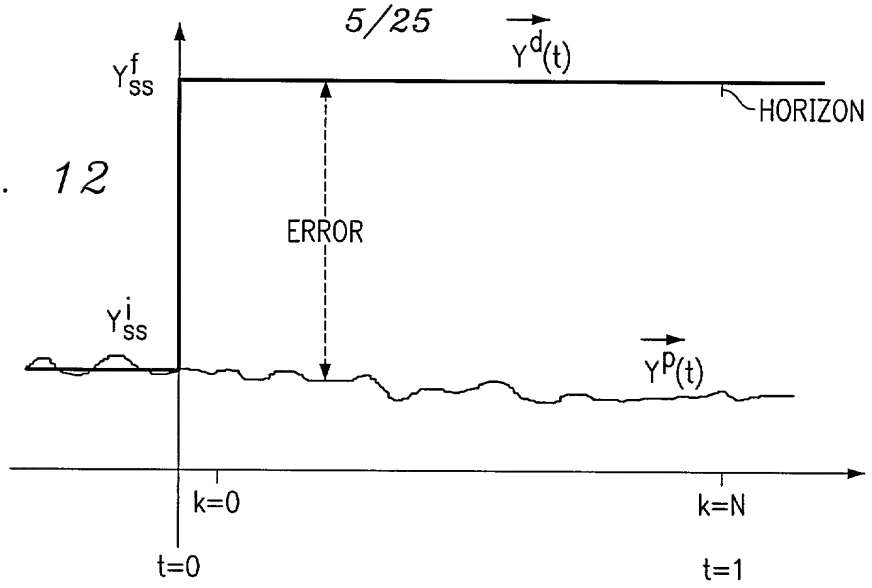


FIG. 12

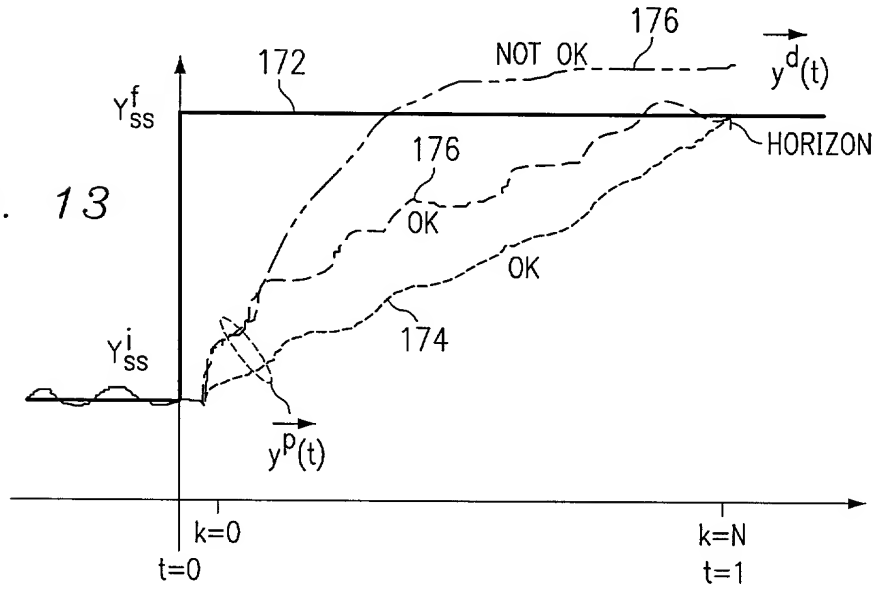


FIG. 13

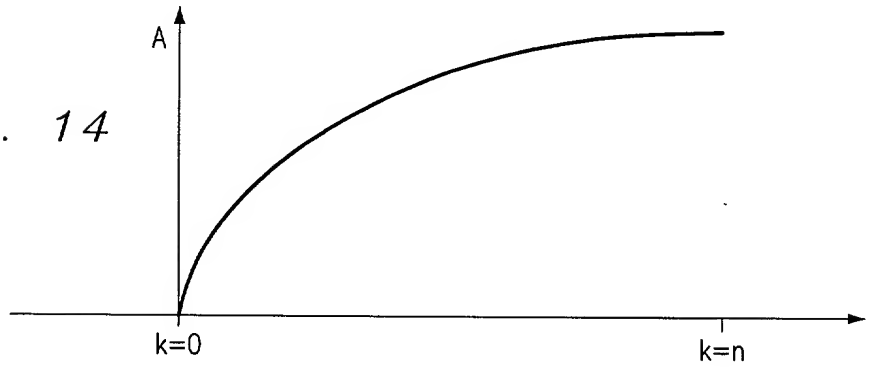


FIG. 14

Patent Application Publication

FIG. 15

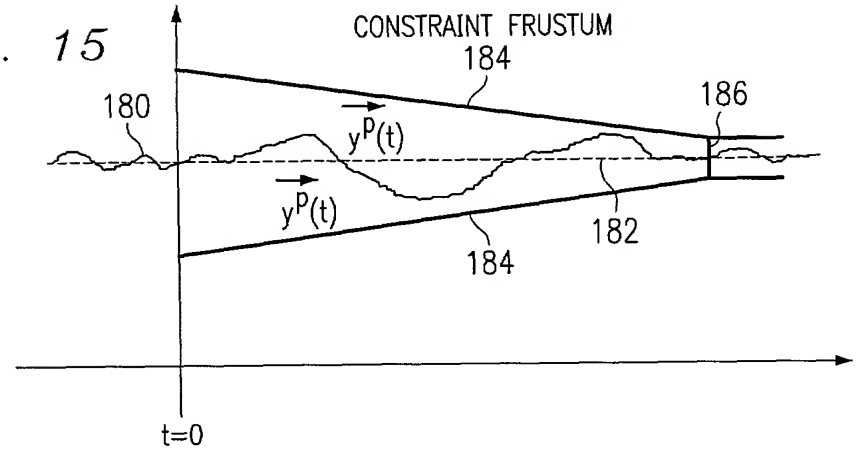
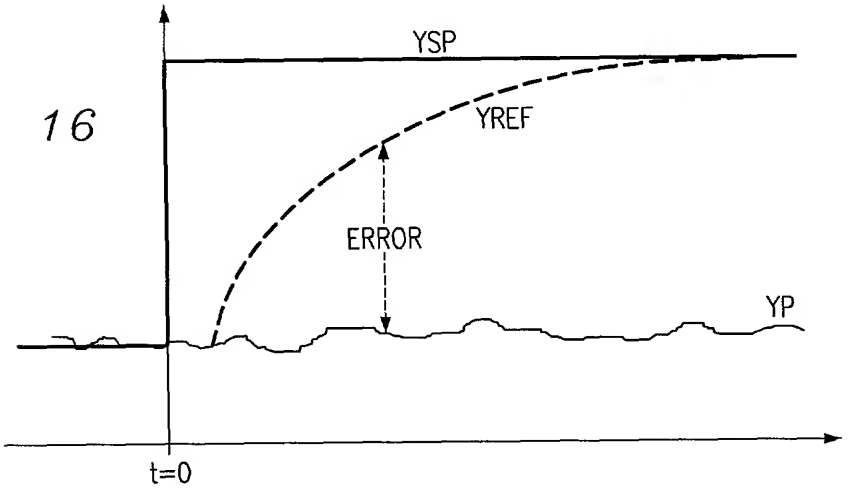


FIG. 16



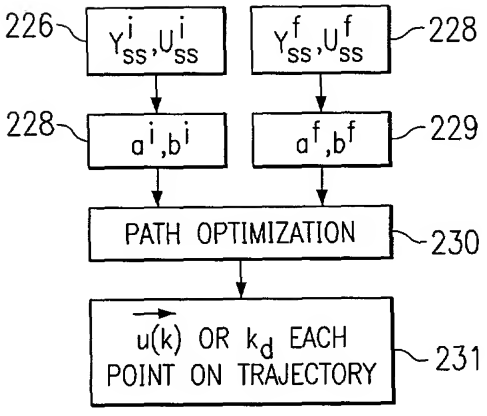


FIG. 18

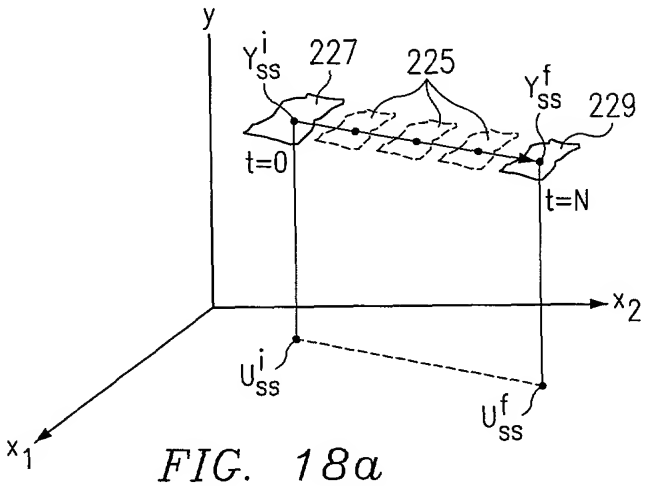


FIG. 18a

FIG. 17

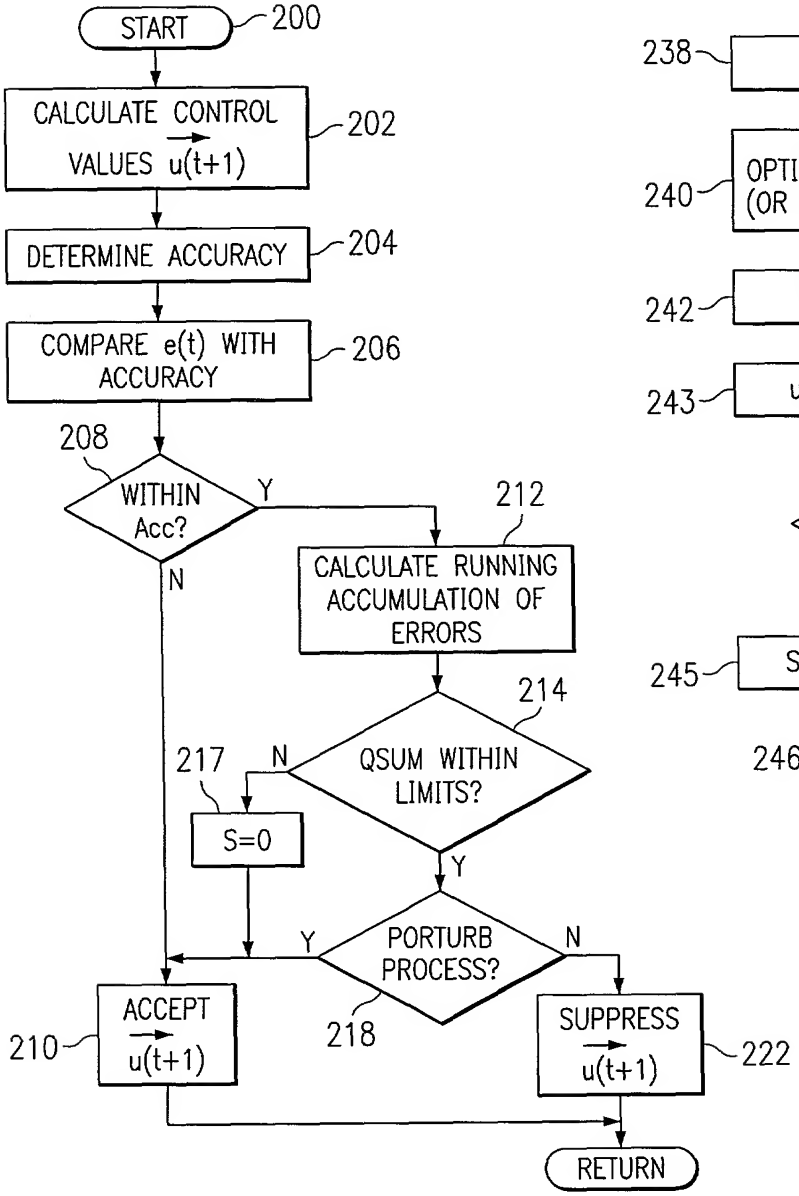

START
200
CALCULATE CONTROL VALUES u(t+1)
202
DETERMINE ACCURACY
204
COMPARE e(t) WITH ACCURACY
206
208
WITHIN Acc?
Y
N
212
CALCULATE RUNNING ACCUMULATION OF ERRORS
214
QSUM WITHIN LIMITS?
217
N
S=0
Y
PORTURB PROCESS?
Y
N
218
ACCEPT u(t+1)
210
SUPPRESS u(t+1)
222
RETURN

FIG. 19

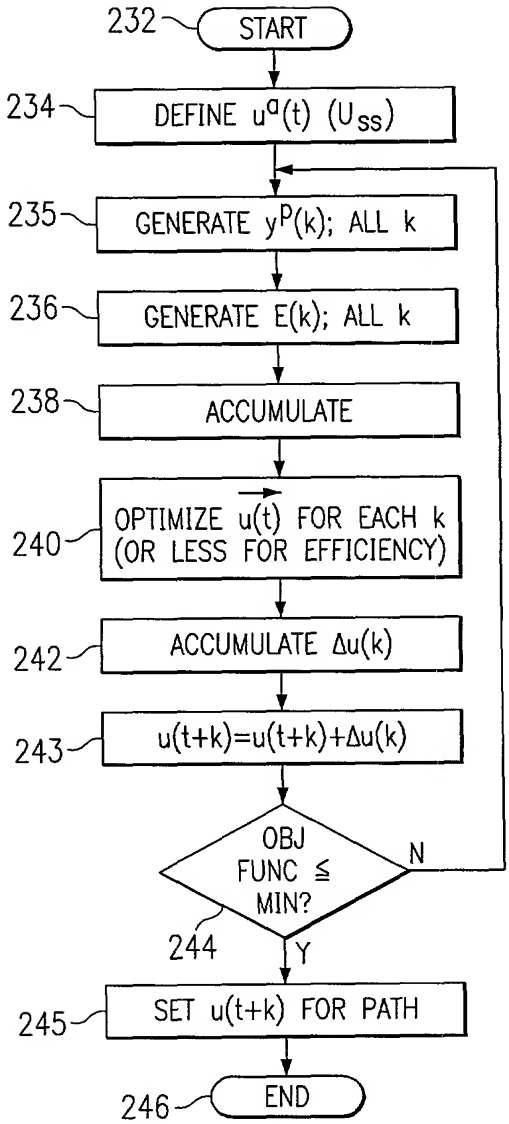

232
START
234
DEFINE $u^Q(t)$ (U_{ss})
235
GENERATE $y^P(k)$; ALL k
236
GENERATE E(k); ALL k
238
ACCUMULATE
240
OPTIMIZE u(t) FOR EACH k (OR LESS FOR EFFICIENCY)
242
ACCUMULATE Δu(k)
243
u(t+k)=u(t+k)+Δu(k)
OBJ FUNC ≦ MIN?
N
244
Y
245
SET u(t+k) FOR PATH
246
END

FIG. 20

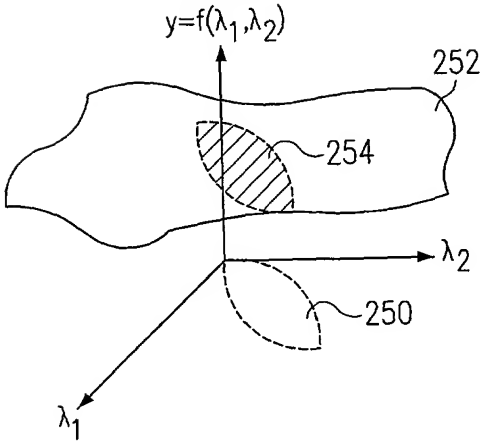


FIG. 21

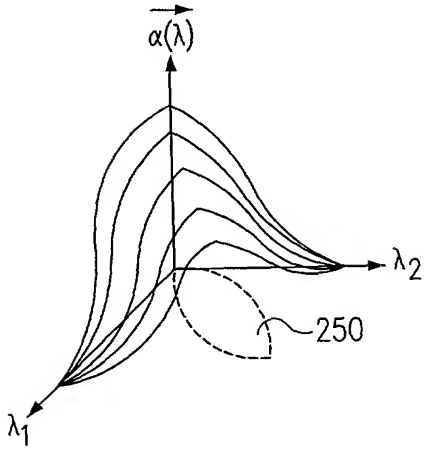


FIG. 22

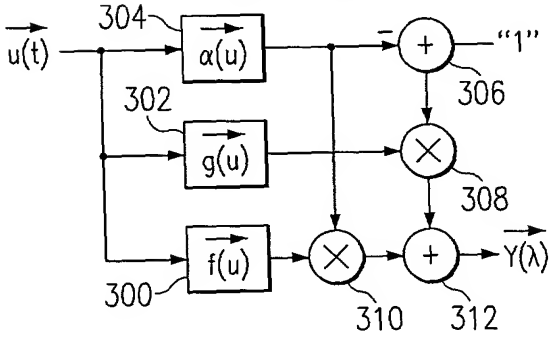


FIG. 23

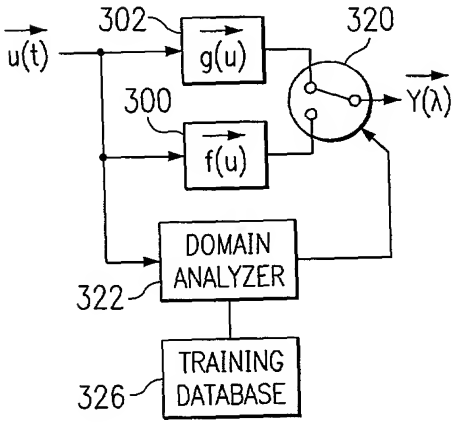
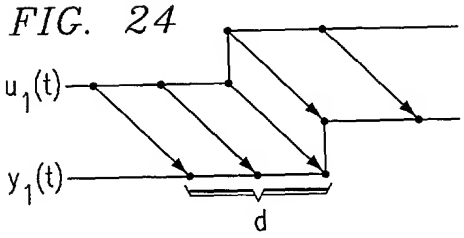


FIG. 24



Patent Application - Attorney Docket

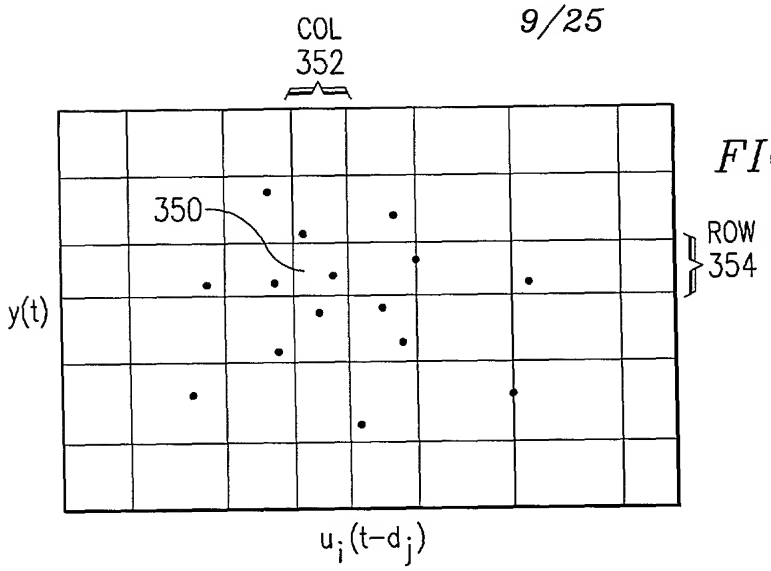


FIG. 25

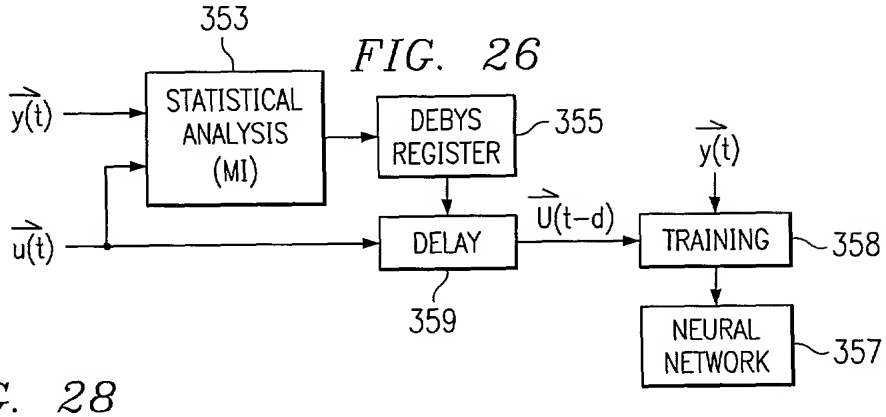


FIG. 26

FIG. 28
(PRIOR ART)

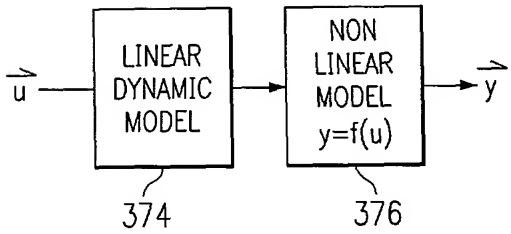
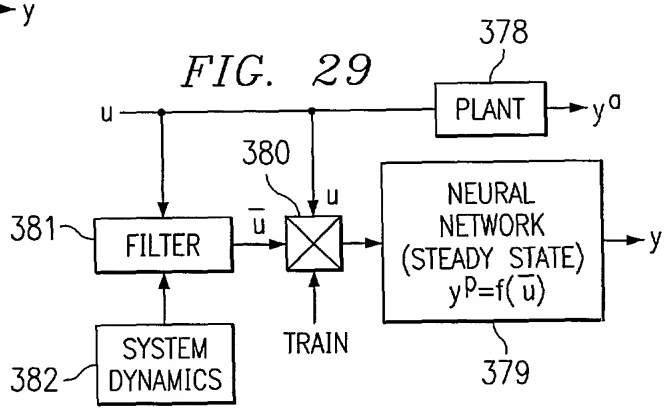


FIG. 29



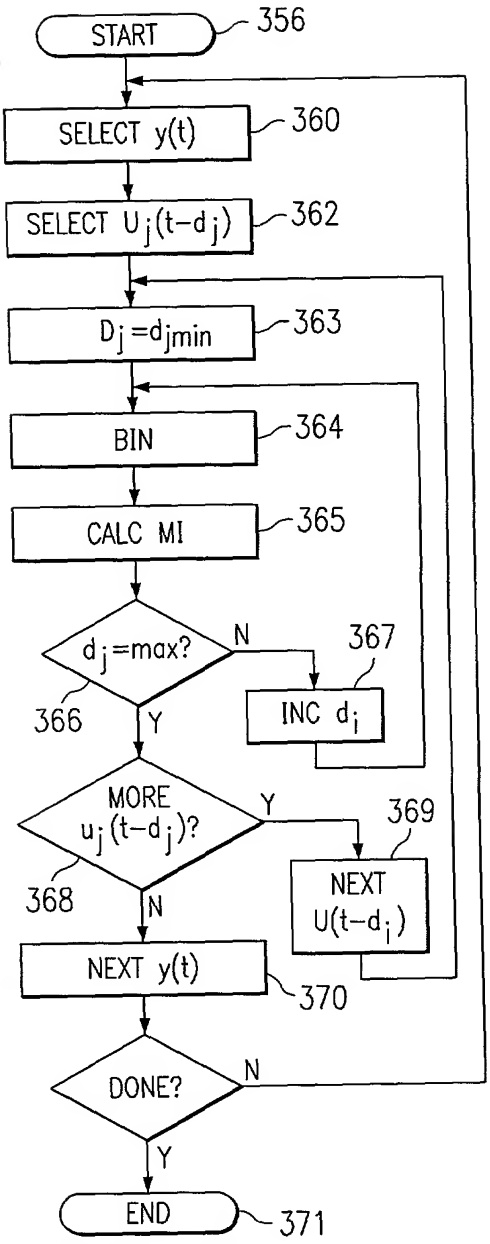


FIG. 27

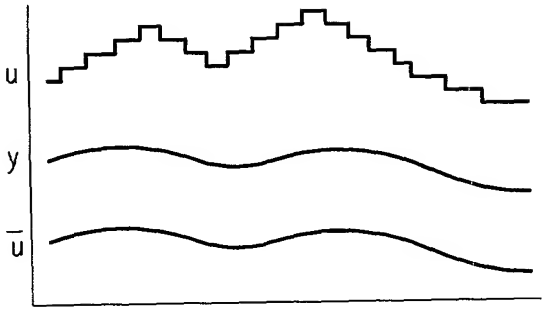


FIG. 30

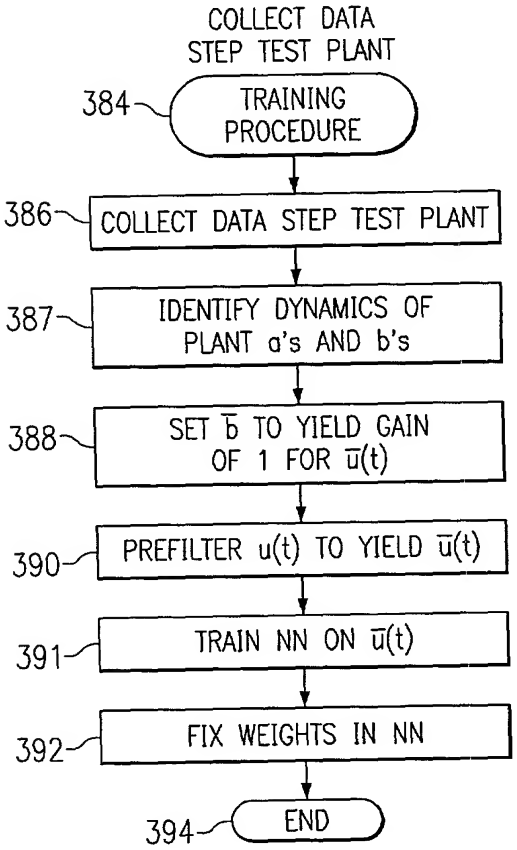


FIG. 31

Replaced by another

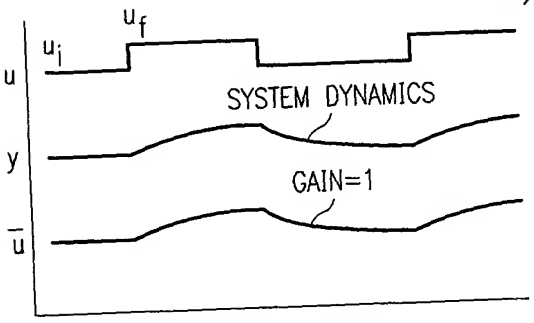


FIG. 32

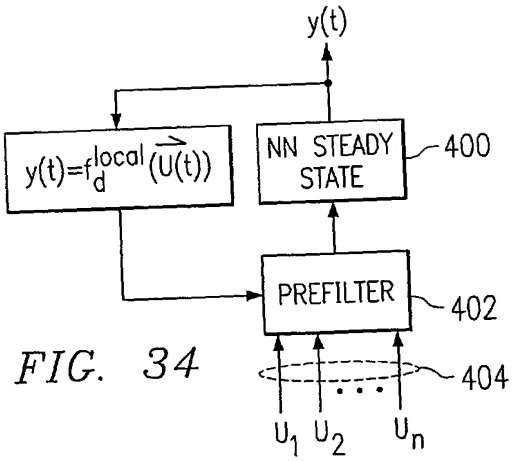


FIG. 34

FIG. 33

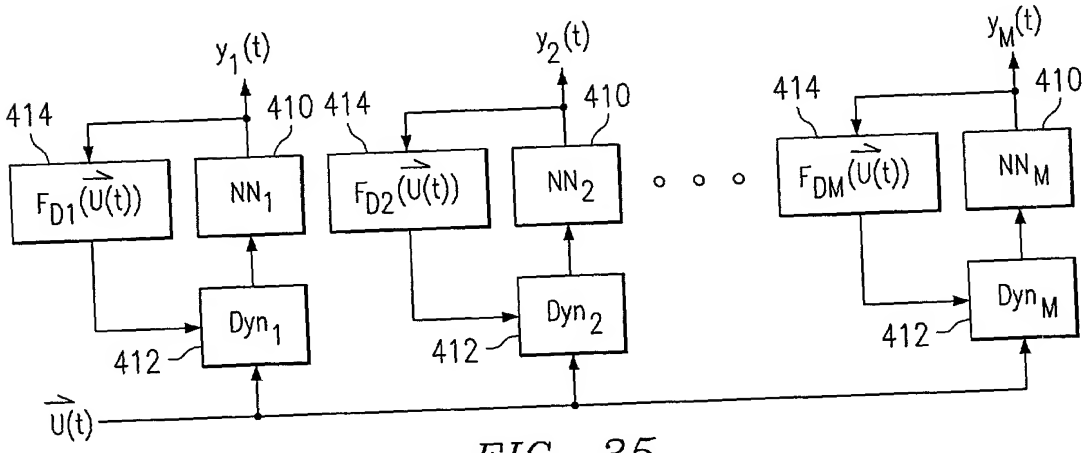


FIG. 35

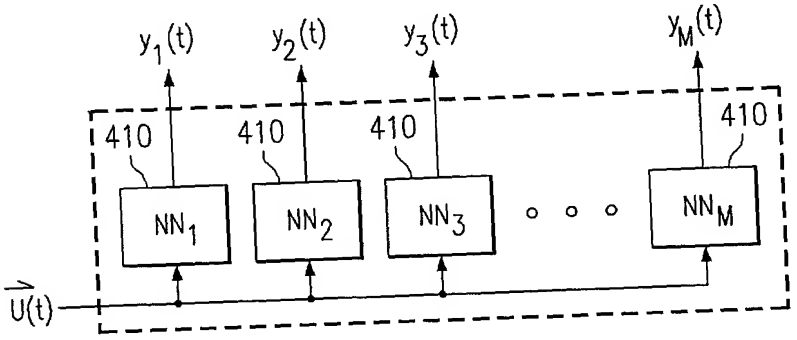
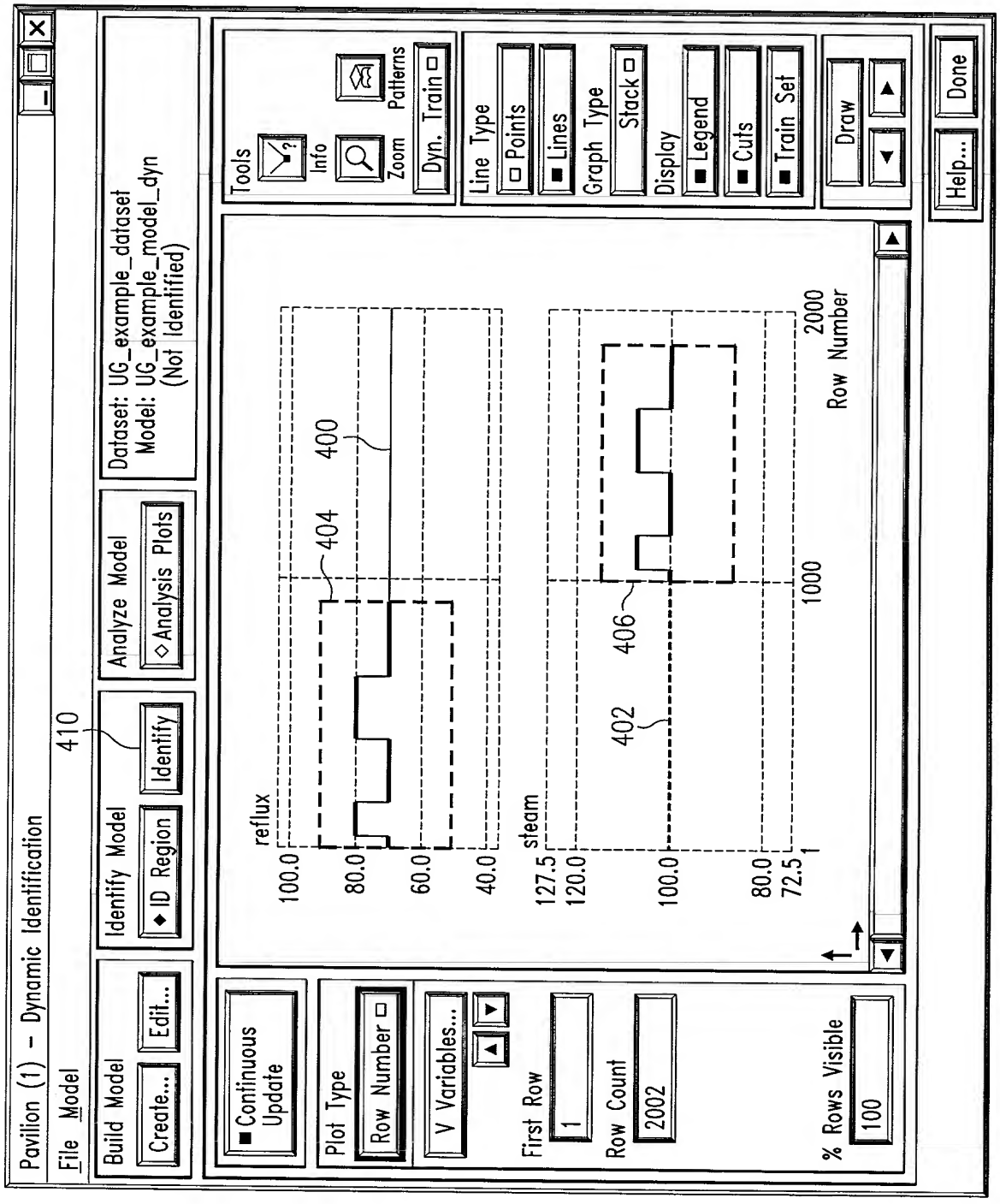


FIG. 36

FIG. 37


Pavilion (1) - Dynamic Identification
File Model
410
Build Model
Create...
Edit...
Identify Model
ID Region
Identify
Analyze Model
Analysis Plots
Dataset: UG_example_dataset
Model: UG_example_model_dyn
(Not Identified)
Tools
Info
Zoom
Patterns
Dyn. Train
Line Type
Points
Lines
Graph Type
Stack
Display
Legend
Cuts
Train Set
Draw
Help...
Done
Continuous Update
Plot Type
Row Number
V Variables...
First Row
1
Row Count
2002
% Rows Visible
100
reflux
100.0
80.0
60.0
40.0
404
400
steam
127.5
120.0
100.0
80.0
72.5
402
406
1
1000
2000
Row Number

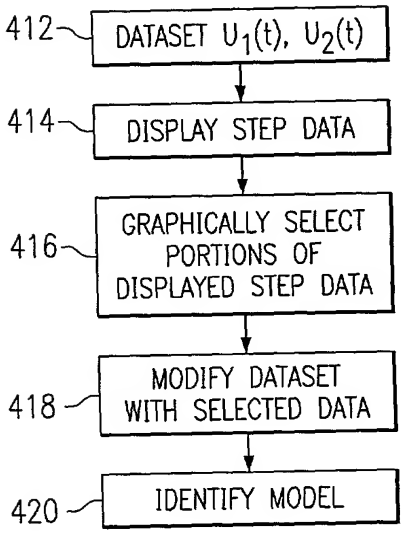

412
DATASET $U_1(t)$, $U_2(t)$
414
DISPLAY STEP DATA
416
GRAPHICALLY SELECT PORTIONS OF DISPLAYED STEP DATA
418
MODIFY DATASET WITH SELECTED DATA
420
IDENTIFY MODEL

FIG. 38

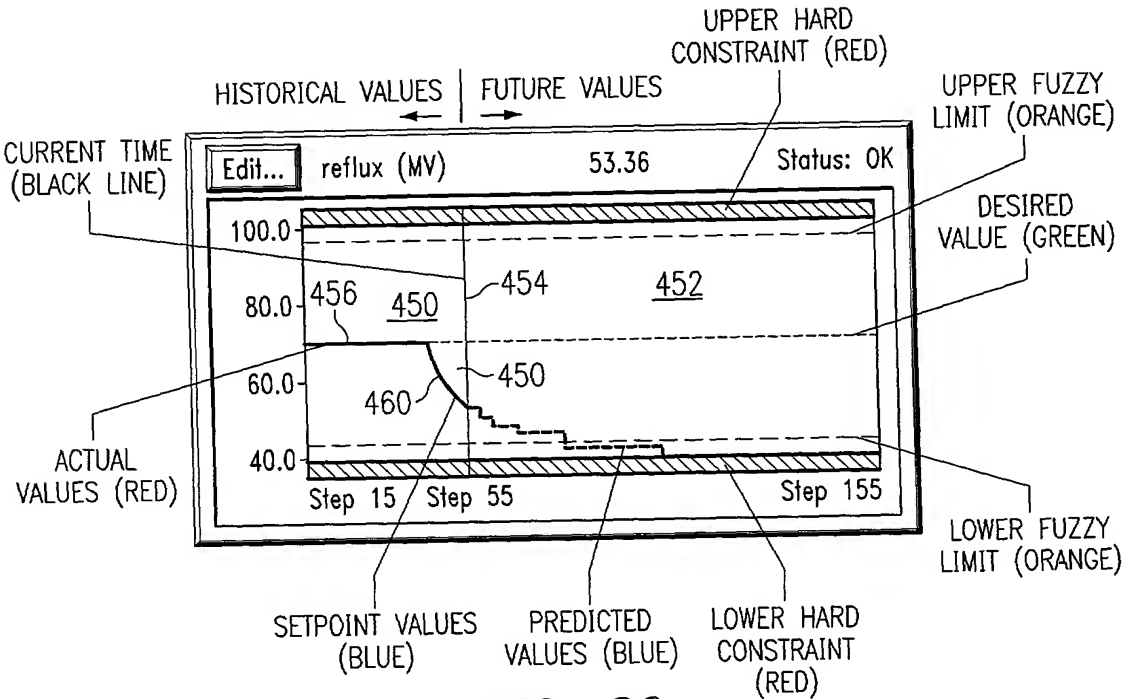

UPPER HARD CONSTRAINT (RED)
HISTORICAL VALUES
FUTURE VALUES
UPPER FUZZY LIMIT (ORANGE)
CURRENT TIME (BLACK LINE)
Edit...
reflux (MV)
53.36
Status: OK
DESIRED VALUE (GREEN)
100.0
80.0
60.0
40.0
456
450
454
452
460
450
ACTUAL VALUES (RED)
Step 15
Step 55
Step 155
LOWER FUZZY LIMIT (ORANGE)
SETPOINT VALUES (BLUE)
PREDICTED VALUES (BLUE)
LOWER HARD CONSTRAINT (RED)

FIG. 39

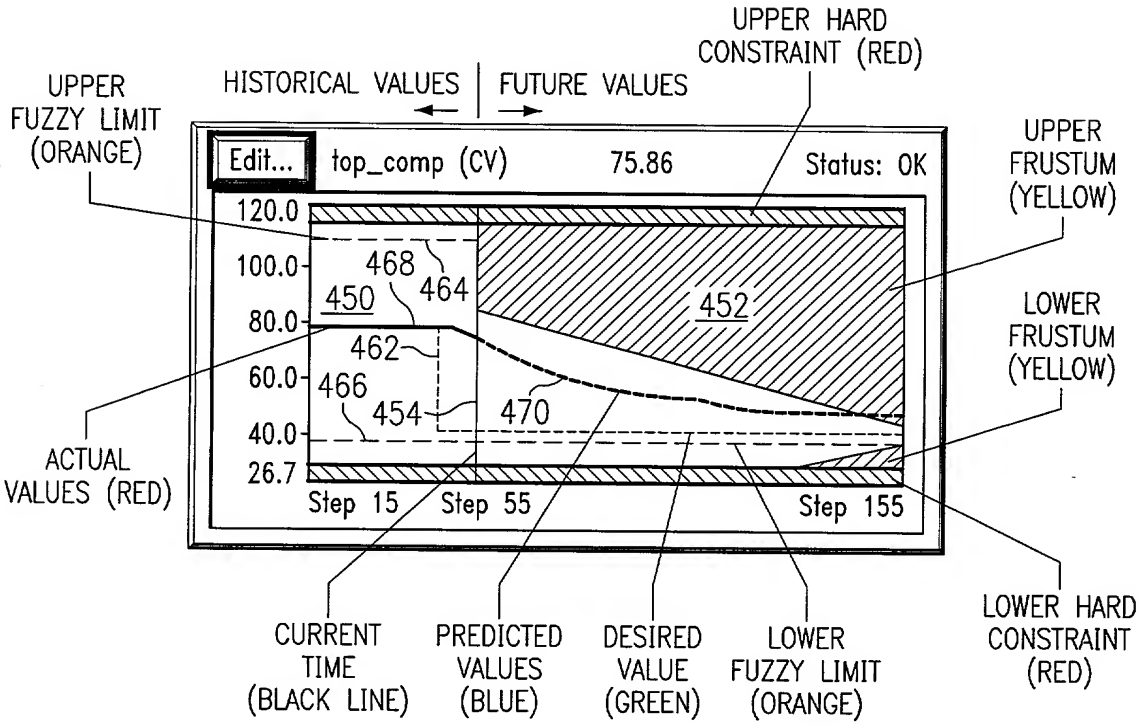

UPPER HARD CONSTRAINT (RED)
UPPER FUZZY LIMIT (ORANGE)
HISTORICAL VALUES
FUTURE VALUES
Edit...
top_comp (CV)
75.86
Status: OK
UPPER FRUSTUM (YELLOW)
120.0
100.0
80.0
60.0
40.0
26.7
468
464
450
452
462
466
454
470
LOWER FRUSTUM (YELLOW)
ACTUAL VALUES (RED)
Step 15
Step 55
Step 155
CURRENT TIME (BLACK LINE)
PREDICTED VALUES (BLUE)
DESIRED VALUE (GREEN)
LOWER FUZZY LIMIT (ORANGE)
LOWER HARD CONSTRAINT (RED)

FIG. 40

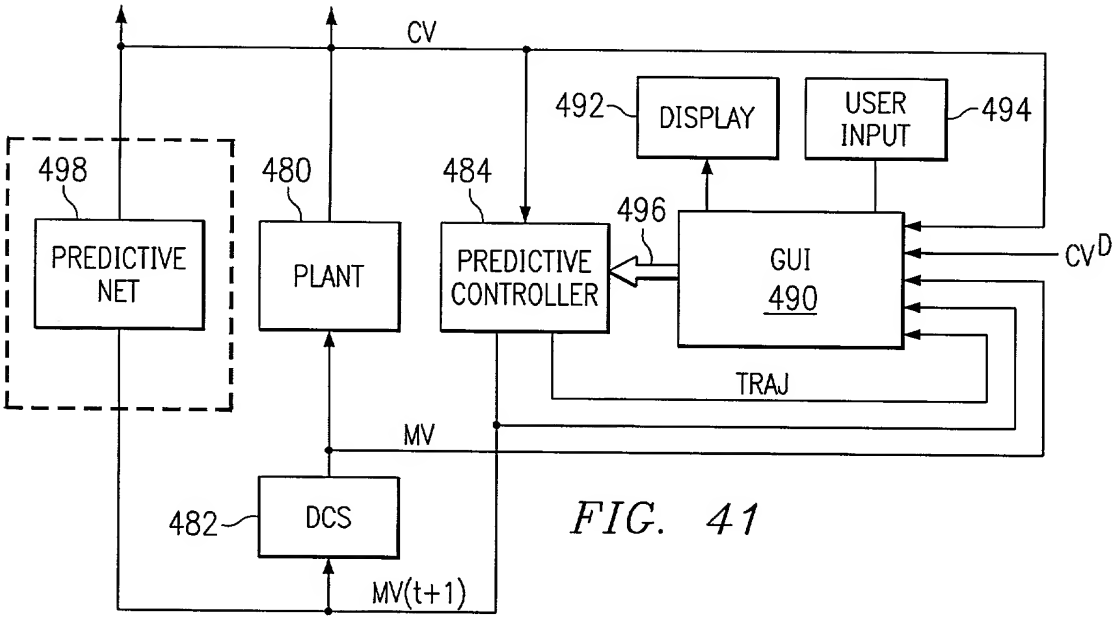

CV
492
DISPLAY
USER INPUT
494
498
480
484
496
PREDICTIVE NET
PLANT
PREDICTIVE CONTROLLER
GUI 490
CV^D
TRAJ
MV
482
DCS
MV(t+1)

FIG. 41

FIG. 42

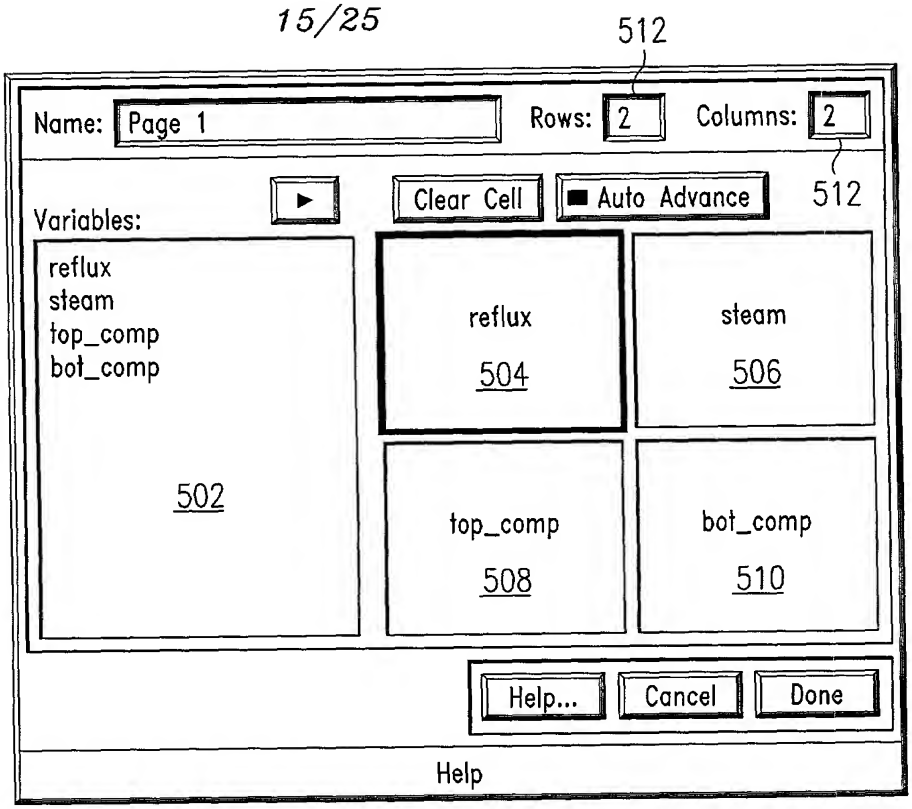

512
Name: Page 1
Rows: 2
Columns: 2
512
Variables:
Clear Cell
Auto Advance
reflux
steam
top_comp
bot_comp
502
reflux
504
steam
506
top_comp
508
bot_comp
510
Help...
Cancel
Done
Help

FIG. 44

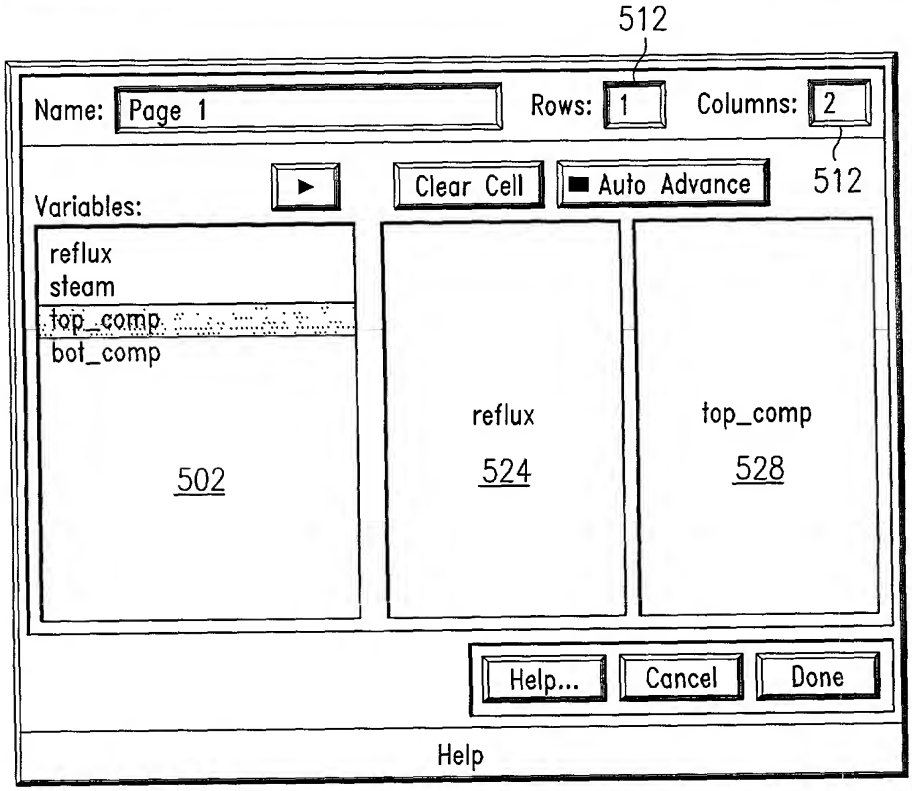

512
Name: Page 1
Rows: 1
Columns: 2
512
Variables:
Clear Cell
Auto Advance
reflux
steam
top_comp
bot_comp
502
reflux
524
top_comp
528
Help...
Cancel
Done
Help

FIG. 43

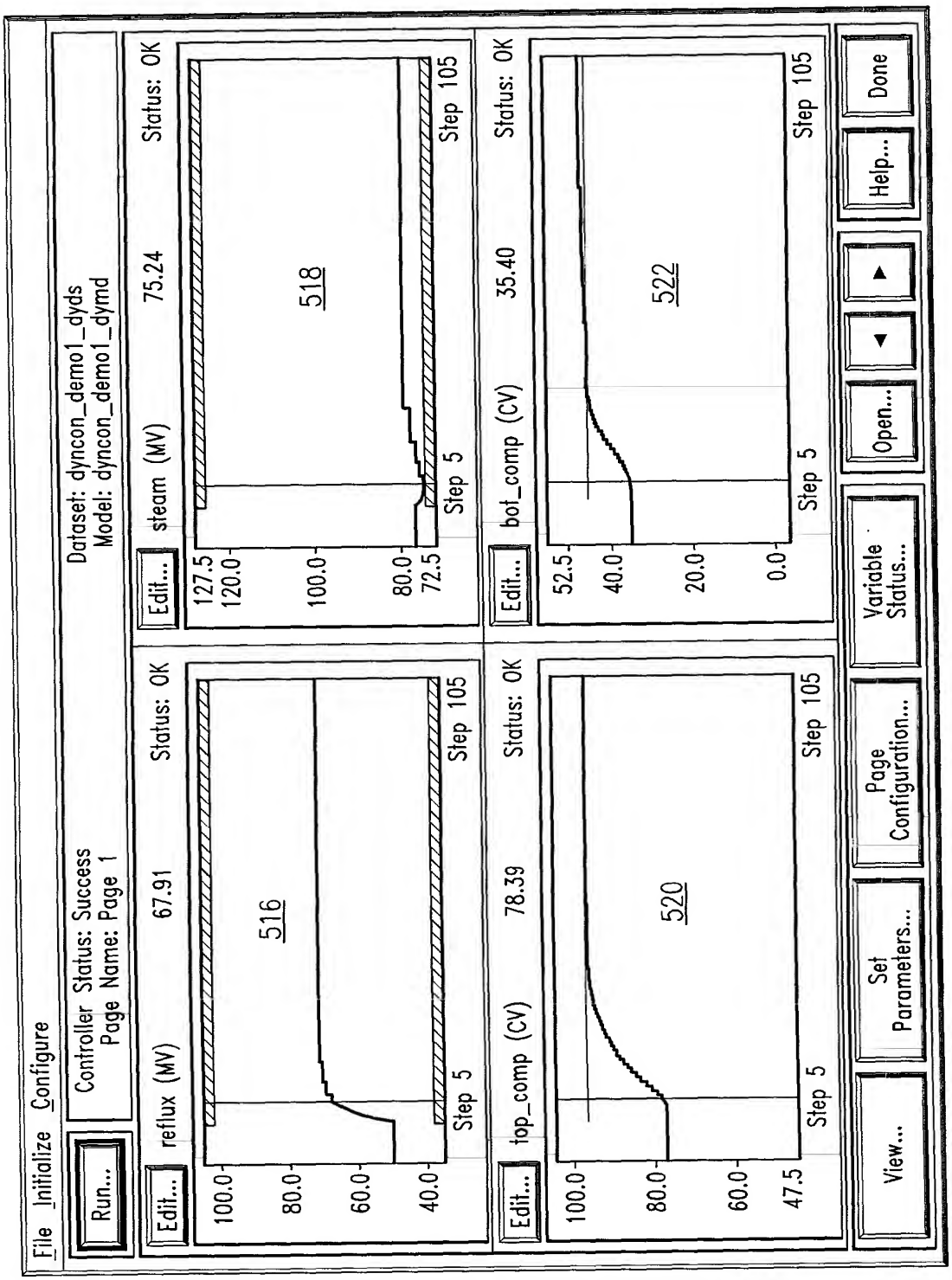
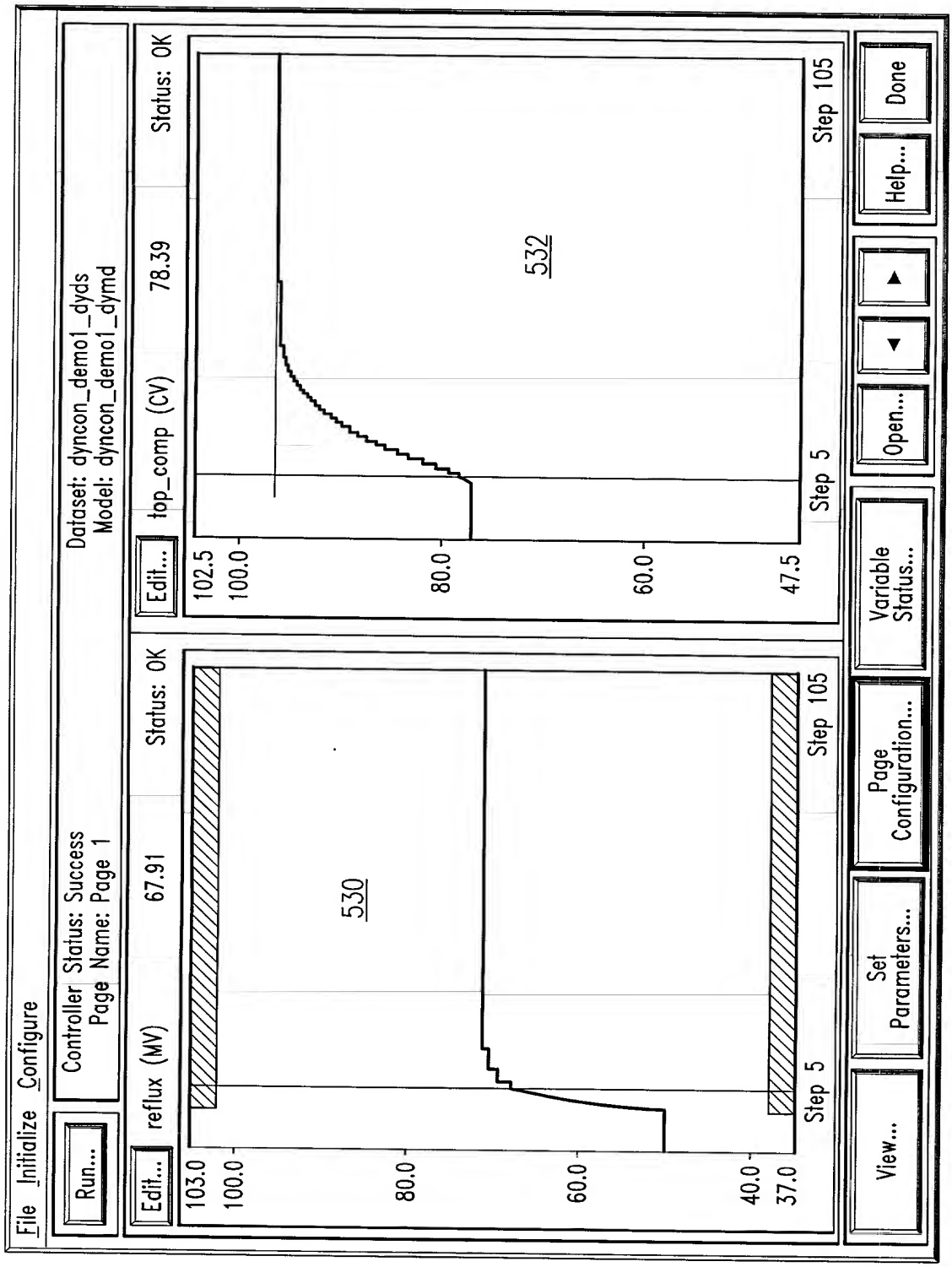

File Initialize Configure
Run...
Controller Status: Success
Page Name: Page 1
Dataset: dyncon_demo1_dyds
Model: dyncon_demo1_dymd
Edit...
reflux (MV)
67.91
Status: OK
516
100.0
80.0
60.0
40.0
Step 5
Step 105
Edit...
steam (MV)
75.24
Status: OK
518
127.5
120.0
100.0
80.0
72.5
Step 5
Step 105
Edit...
top_comp (CV)
78.39
Status: OK
520
100.0
80.0
60.0
47.5
Step 5
Step 105
Edit...
bot_comp (CV)
35.40
Status: OK
522
52.5
40.0
20.0
0.0
Step 5
Step 105
View...
Set Parameters...
Page Configuration...
Variable Status...
Open...
Help...
Done

FIG. 45


File Initialize Configure
Run...
Controller Status: Success
Page Name: Page 1
Dataset: dyncon_demo1_dyds
Model: dyncon_demo1_dymd
Edit...
reflux (MV)
67.91
Status: OK
103.0
100.0
80.0
60.0
40.0
37.0
Step 5
Step 105
530
Edit...
top_comp (CV)
78.39
Status: OK
102.5
100.0
80.0
60.0
47.5
Step 5
Step 105
532
View...
Set Parameters...
Page Configuration...
Variable Status...
Open...
Help...
Done

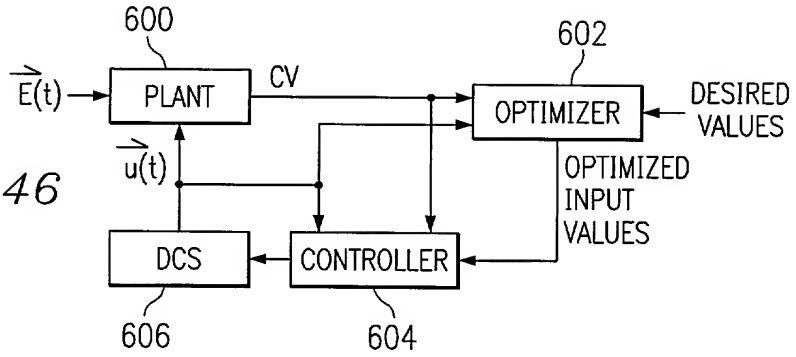


FIG. 46

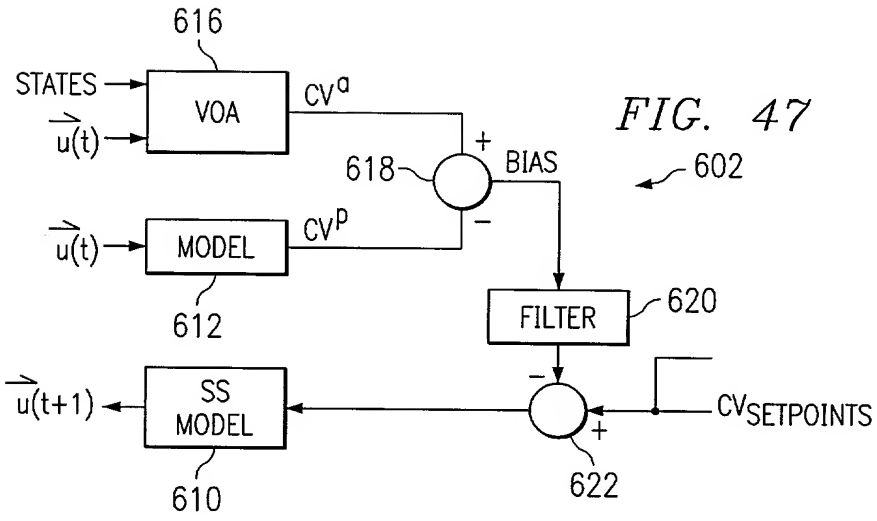
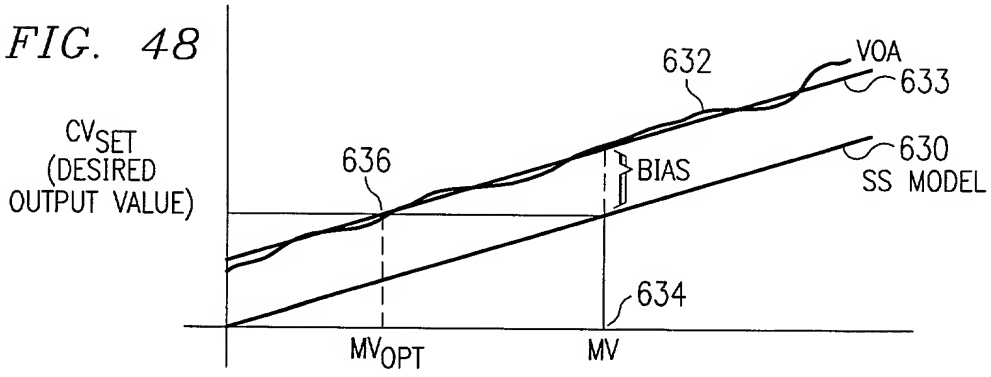


FIG. 47

FIG. 48



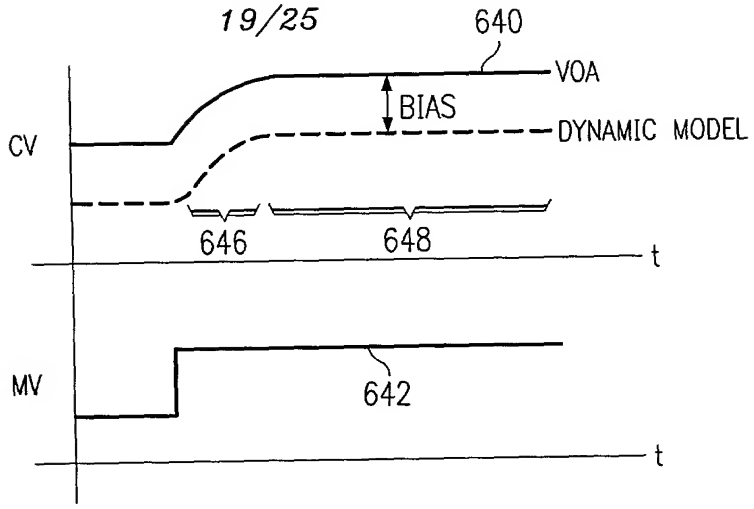


FIG. 49

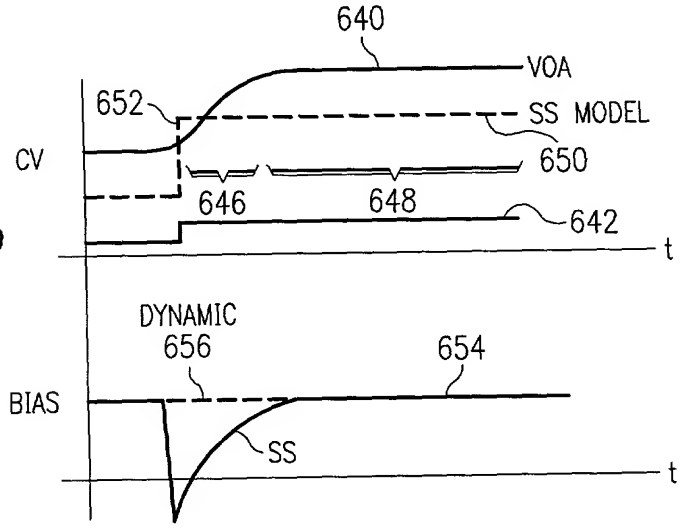


FIG. 50

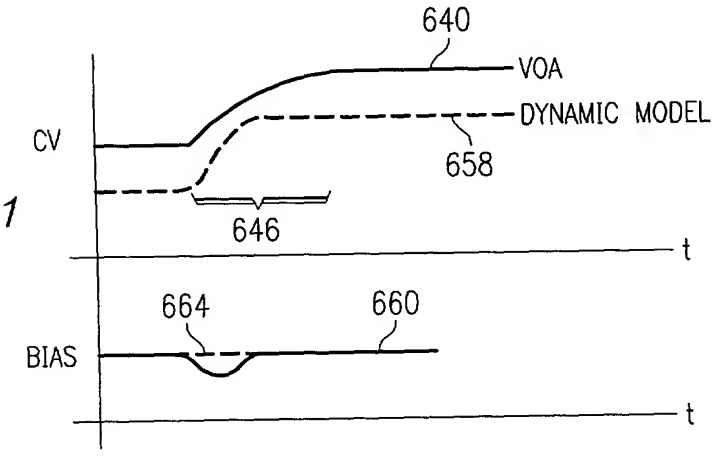


FIG. 51

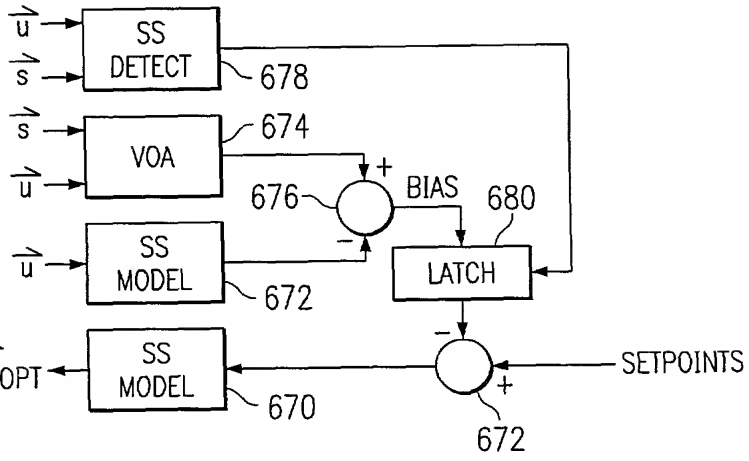


FIG. 52
(PRIOR ART)

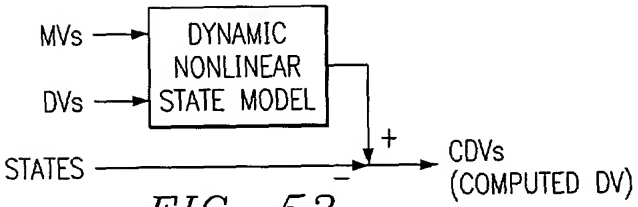


FIG. 53

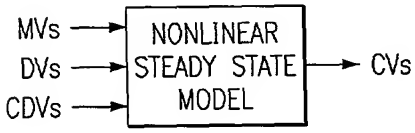


FIG. 54

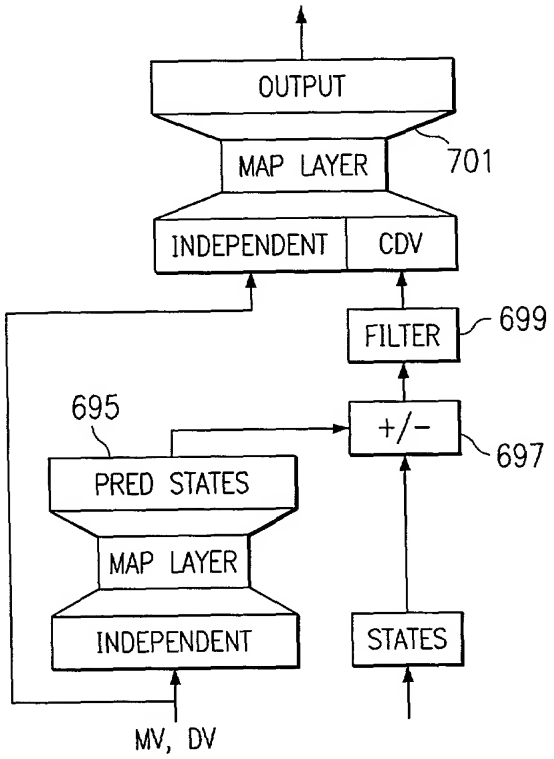


FIG. 53a

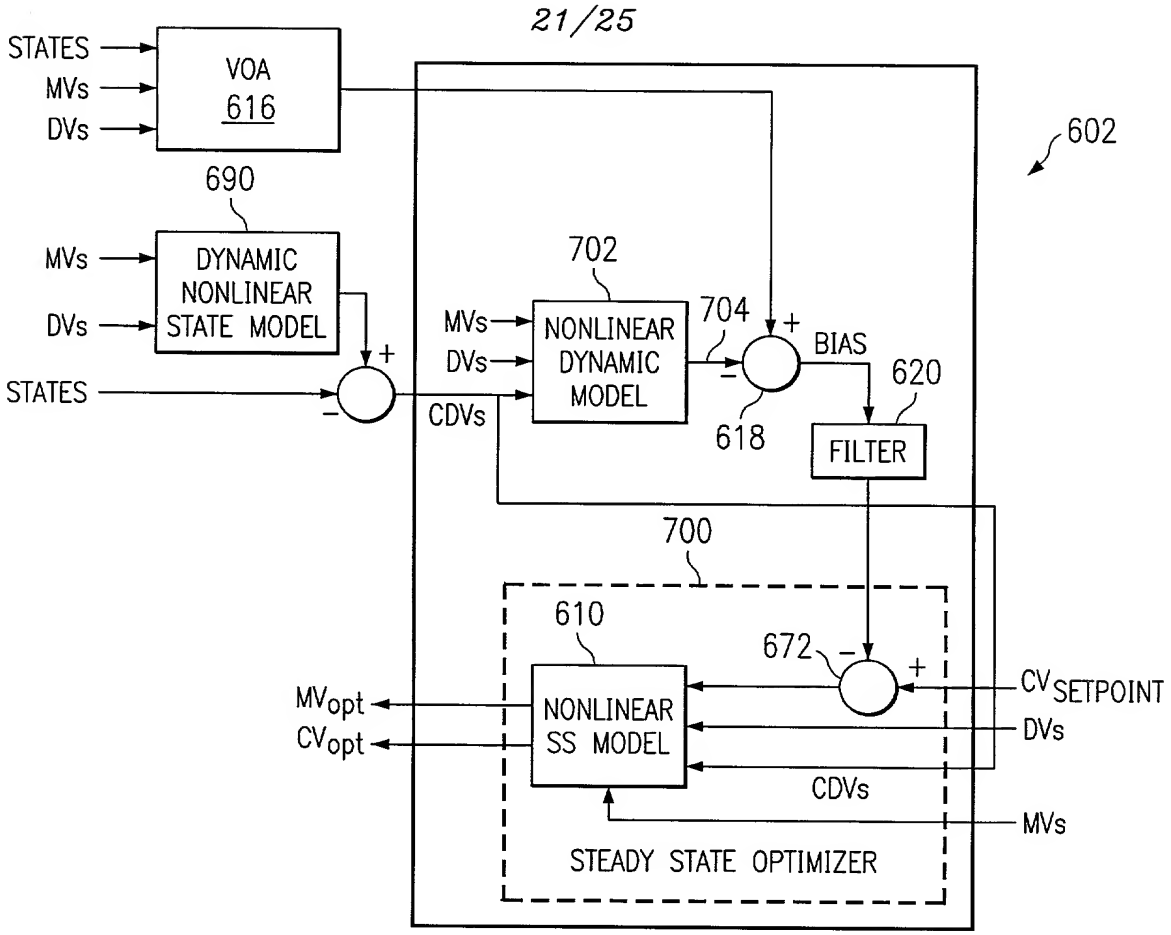

STATES
MVs
DVs
VOA
616
602
690
MVs
DVs
DYNAMIC NONLINEAR STATE MODEL
STATES
+
−
702
MVs
DVs
CDVs
NONLINEAR DYNAMIC MODEL
704
+
−
618
BIAS
620
FILTER
700
610
672
−
+
MVopt
CVopt
NONLINEAR SS MODEL
CVSETPOINT
DVs
CDVs
MVs
STEADY STATE OPTIMIZER

FIG. 55

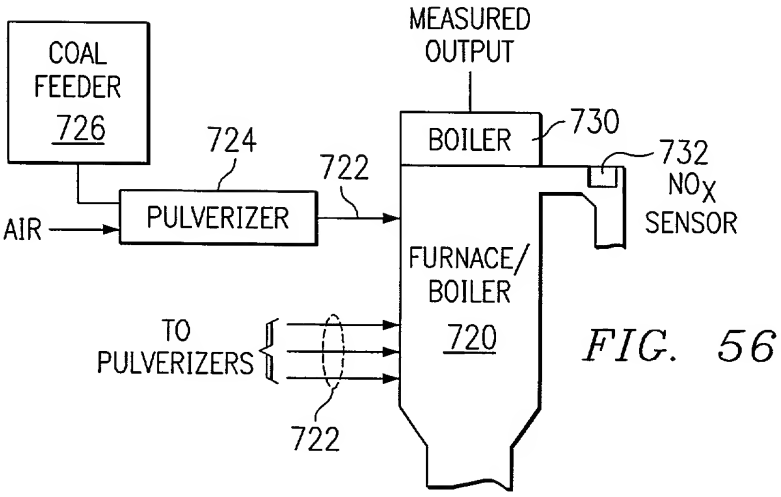

COAL FEEDER
726
MEASURED OUTPUT
BOILER
730
732
NOX SENSOR
724
722
AIR
PULVERIZER
FURNACE/ BOILER
720
TO PULVERIZERS
722

FIG. 56

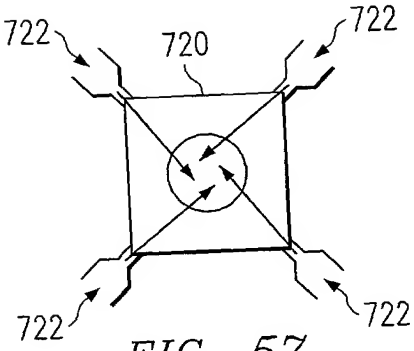


FIG. 57

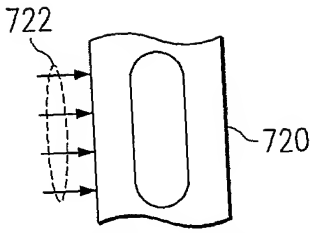


FIG. 57a

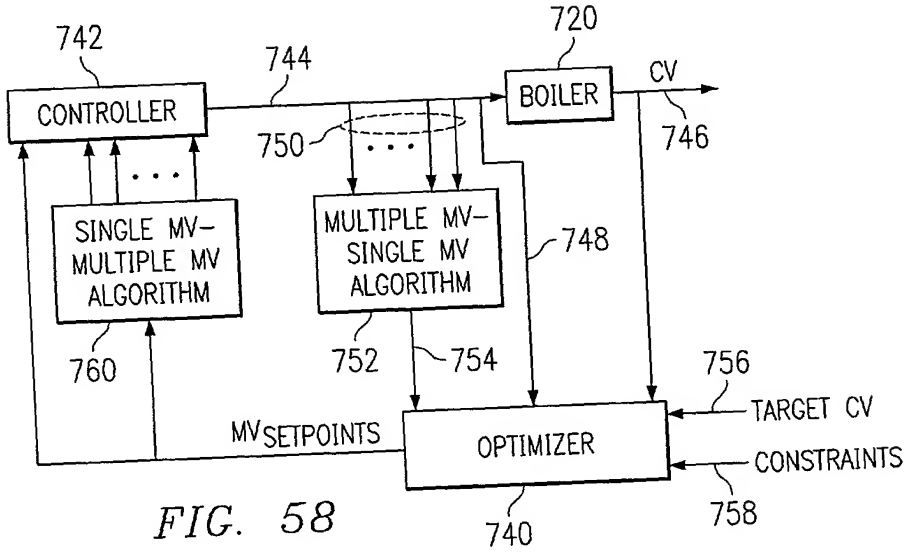


FIG. 58

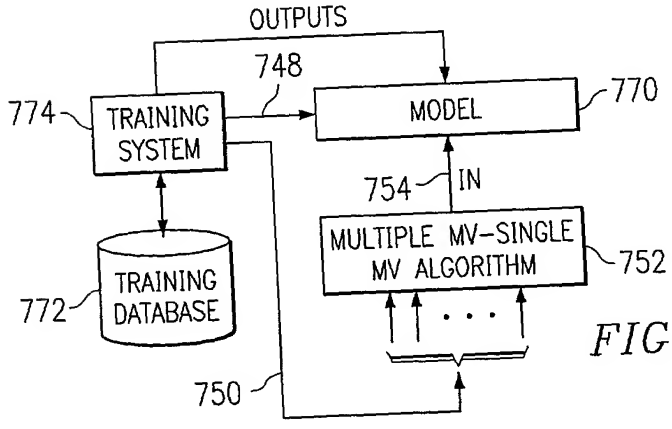
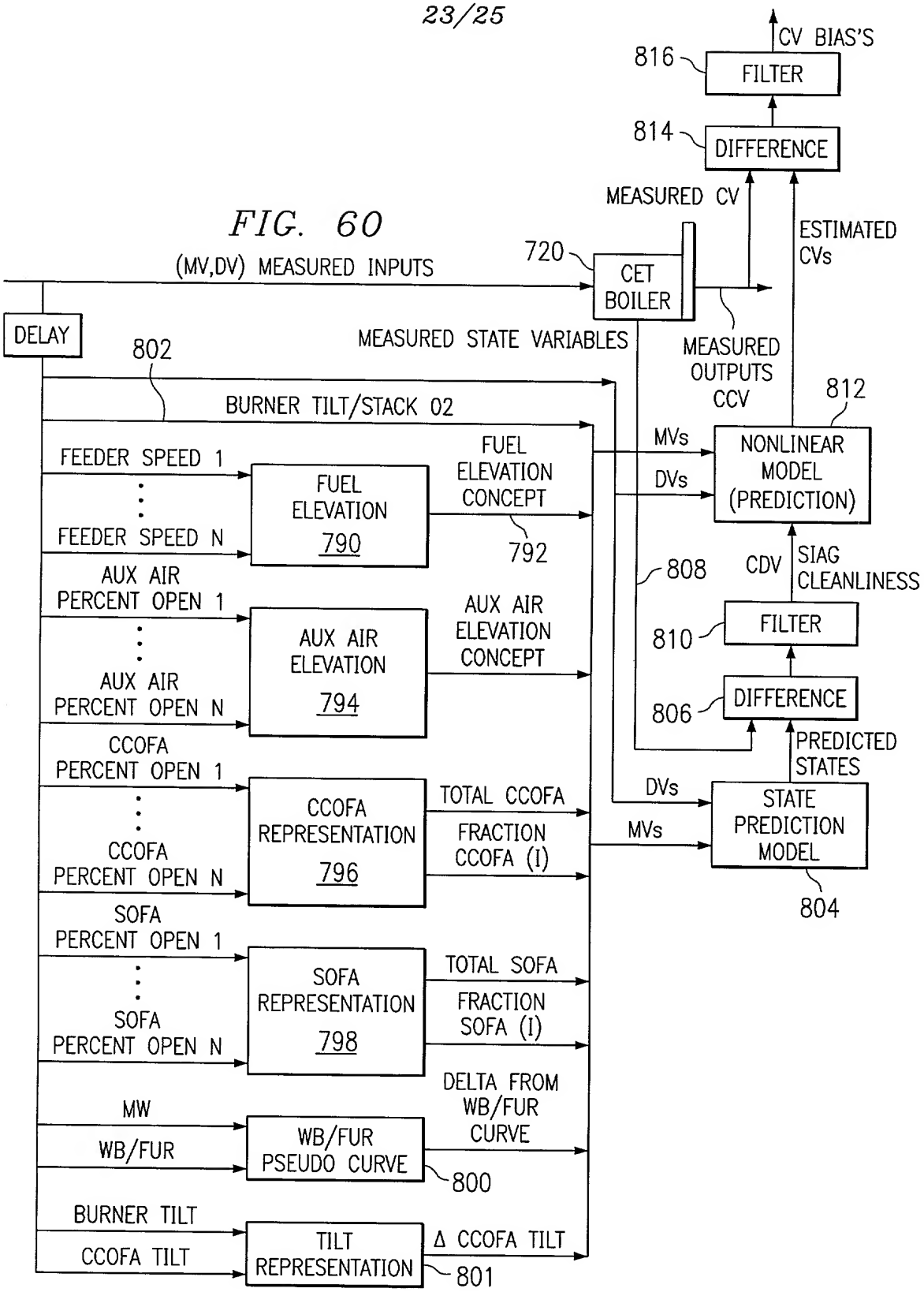


FIG. 59

US 6,055,483

FIG. 60


CV BIAS'S
816
FILTER
814
DIFFERENCE
MEASURED CV
ESTIMATED CVs
720
CET BOILER
(MV,DV) MEASURED INPUTS
DELAY
802
MEASURED STATE VARIABLES
MEASURED OUTPUTS CCV
812
BURNER TILT/STACK 02
MVs
DVs
NONLINEAR MODEL (PREDICTION)
FEEDER SPEED 1
FEEDER SPEED N
FUEL ELEVATION 790
FUEL ELEVATION CONCEPT
792
808
CDV
SIAG CLEANLINESS
AUX AIR PERCENT OPEN 1
AUX AIR PERCENT OPEN N
AUX AIR ELEVATION 794
AUX AIR ELEVATION CONCEPT
810
FILTER
806
DIFFERENCE
CCOFA PERCENT OPEN 1
CCOFA PERCENT OPEN N
CCOFA REPRESENTATION 796
TOTAL CCOFA
FRACTION CCOFA (I)
PREDICTED STATES
DVs
MVs
STATE PREDICTION MODEL
804
SOFA PERCENT OPEN 1
SOFA PERCENT OPEN N
SOFA REPRESENTATION 798
TOTAL SOFA
FRACTION SOFA (I)
DELTA FROM WB/FUR CURVE
MW
WB/FUR
WB/FUR PSEUDO CURVE
800
BURNER TILT
CCOFA TILT
TILT REPRESENTATION
Δ CCOFA TILT
801

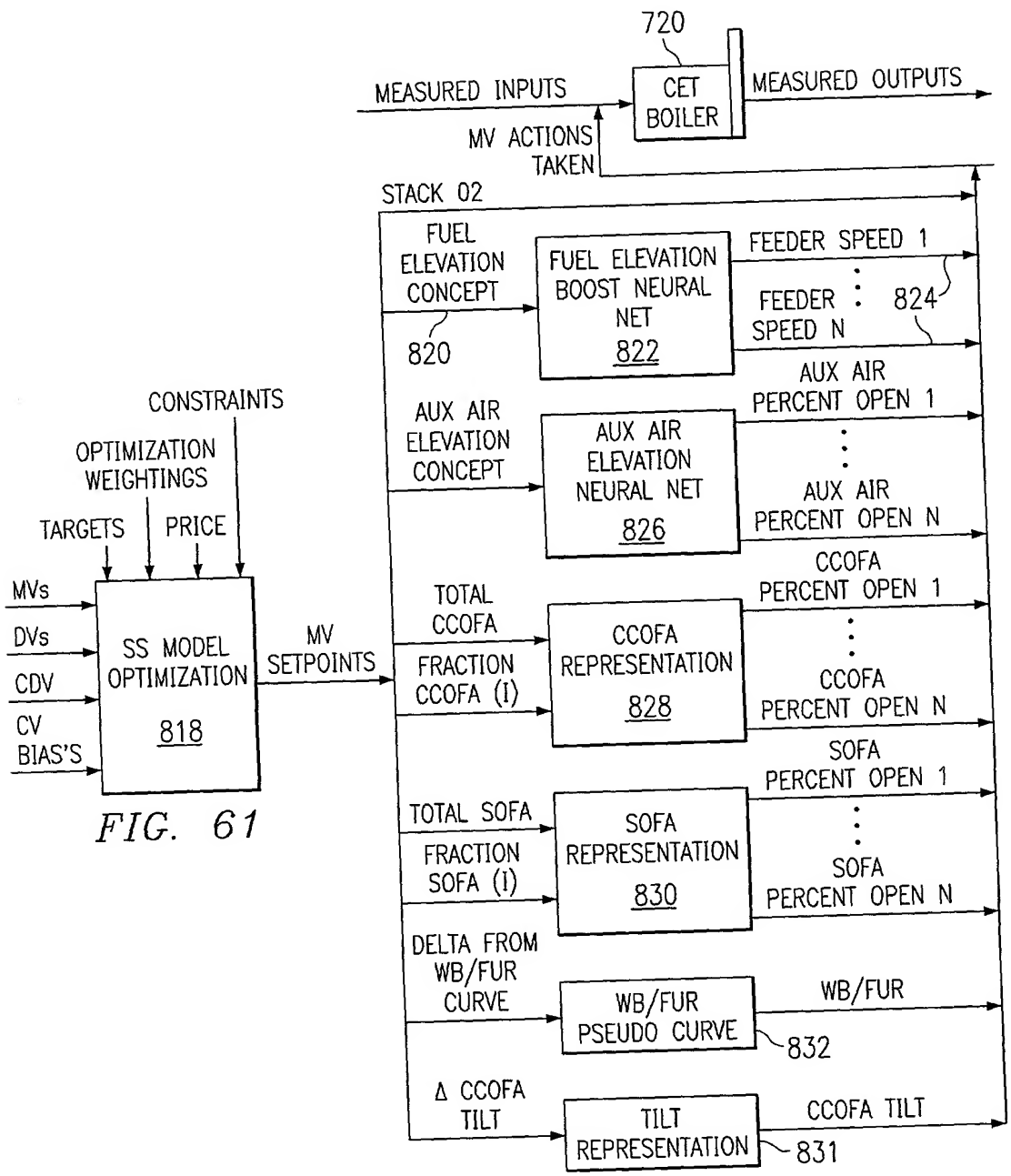


FIG. 61

EP 0 823 662 A2

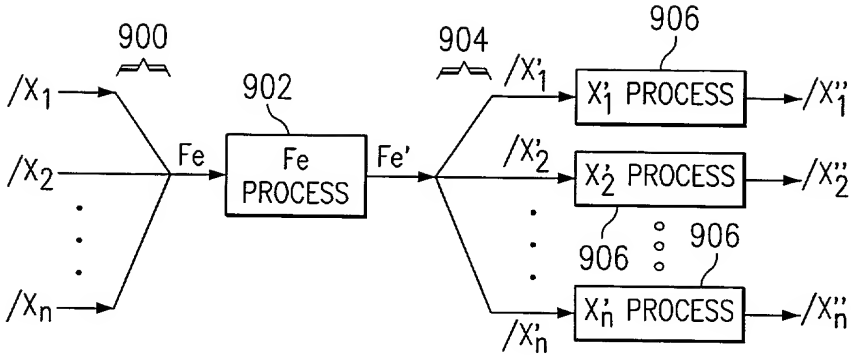


FIG. 62

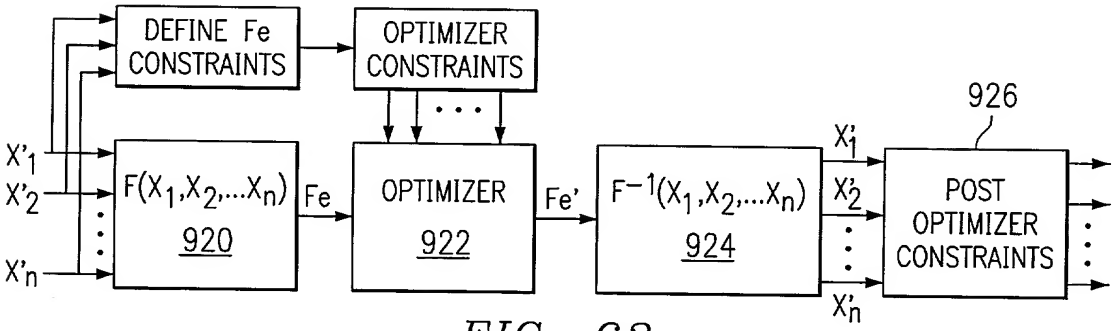


FIG. 63

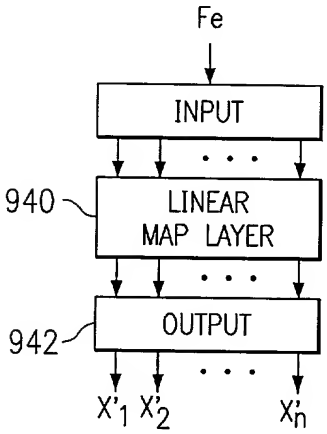


FIG. 64

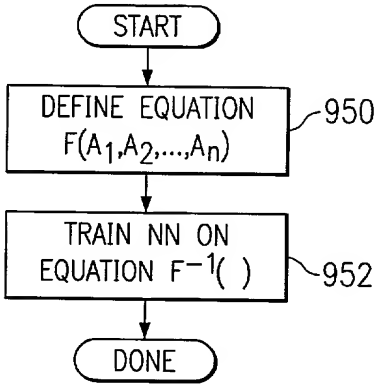


FIG. 65